CLAIMS

What is claimed is:

1. A fiber optic module for coupling photons between optoelectronic devices and optical fibers, the fiber optic module comprising:

a base;

a first printed circuit board (PCB) arranged parallel to a first optical axis of a first optoelectronic device, the first optoelectronic device having terminals coupled to the first printed circuit board;

a second printed circuit board (PCB) arranged parallel to a second optical axis of a second optoelectronic device, the second optoelectronic device having terminals coupled to the second printed circuit board;

a third printed circuit board (PCB) arranged parallel to a third optical axis of a third optoelectronic device, the third optoelectronic device having terminals coupled to the third printed circuit board, and

wherein the third printed circuit board and the third optoelectronic device to provide redundancy for the fiber optic module.

2. The fiber optic module of claim 1 further comprising:

a housing coupled to the base.

3. The fiber optic module of claim 2 wherein,

the housing is a shielded housing to encase the first, second and third printed circuit boards to reduce electromagnetic interference (EMI).

4. The fiber optic module of claim 1 wherein,

the base has a first, a second and a third opening;

the first printed circuit board has a plurality of pins extending through the first opening in the base to couple to a system;

the second printed circuit board has a plurality of pins extending through the second opening in the base to couple to the system; and

the third printed circuit board has a plurality of pins extending through the third opening in the base to couple to the system.

5. The fiber optic module of claim 4 wherein,

the first, second and third openings in the base are a plurality of pin holes in the base.

6. The fiber optic module of claim 4 wherein,

the first, second and third openings in the base are a first, second, and third cutouts respectively in the base.

7. The fiber optic module of claim 1 wherein, the first, second and third printed circuit boards further comprise:

electrical components coupled between the first optoelectronic device and the plurality of pins of the first printed circuit board and between the second optoelectronic device and the plurality of pins of the second printed circuit board and between the third optoelectronic device and the plurality of pins of the third printed circuit board, the electrical components for controlling the first, second, and third optoelectronic devices.

8. The fiber optic module of claim 7 wherein, the first printed circuit board further comprises:

a ground plane to reduce electro-magnetic fields generated by the electrical components.

9. The fiber optic module of claim 7 wherein, the second printed circuit board further comprises:

a ground plane to reduce electro-magnetic fields generated by the electrical components.

10. The fiber optic module of claim 7 wherein, the third printed circuit board further comprises:

a ground plane to reduce electro-magnetic fields generated by the electrical components.

11. The fiber optic module of claim 1 further comprising:

a first optical block coupled to the first optoelectronic device, the first optical block having a first opening to receive the first optoelectronic device, and a first lens to couple photons between the first optoelectronic device and an optical fiber;

a second optical block coupled to the second optoelectronic device, the second optical block having a second opening to receive the second optoelectronic device, and a second lens to couple photons between the second optoelectronic device and an optical fiber; and

a third optical block coupled to the third optoelectronic device, the third optical block having a third opening to receive the third optoelectronic device, and a third lens to couple photons between the third optoelectronic device and an optical fiber.

12. The fiber optic module of claim 11 further comprising:

a nose to receive an optical fiber connector and to hold an optical fiber substantially fixed and aligned with an optical opening of the optical block.

13. The fiber optic module of claim 12 further comprising:

a nose shield surrounding the nose to reduce electromagnetic interference.

14. The fiber optic module of claim 1 further comprising:

an optical block coupled to the first, second and third optoelectronic devices, the optical block having

a first, second and third openings to receive the first, second and third optoelectronic devices respectively, and

a first, second, and third lens to couple photons between the first, second and third optoelectronic devices and first, second, and third optical fibers respectively.

15. The fiber optic module of claim 14, wherein,

the first and third lens of the optical block to launch photons into the first optical fiber and the third optical fiber from the first and third optoelectronic devices.

16. The fiber optic module of claim 14, wherein,

the second lens of the optical block is a focusing lens to receive photons from the second optical fiber and to couple them to the second optoelectronic device.

17. The fiber optic module of claim 14 further

comprising:

a nose to receive an optical fiber connector and to hold an optical fiber substantially fixed and aligned with an optical opening of the optical block.

18. The fiber optic module of claim 17 further comprising:

a nose shield surrounding the nose to reduce electromagnetic interference.

19. The fiber optic module of claim 1, wherein,

the first optoelectronic device is a photodetector and the second and third optoelectronic devices are emitters.

20. The fiber optic module of claim 19, wherein,

the emitters are vertical cavity surface emitting lasers (VCSELs).

21. The fiber optic module of claim 1, wherein,

the first optoelectronic device is an emitter and the second and third optoelectronic devices are photodetectors.

22. The fiber optic module of claim 21, wherein,

the emitter is a vertical cavity surface emitting laser (VCSEL).

23. A method of providing redundancy in a fiber optic module comprising:

providing a first fiber optic channel in a fiber optic module,

providing a second fiber optic channel in a fiber optic module, and

providing a third fiber optic channel in a fiber optic module to replace a failing fiber optic channel in the fiber optic module.

24. The method of claim 23 wherein,
the third fiber optic channel in the fiber optic module becomes operational when the first fiber optic channel fails.

25. The method of claim 23 wherein,
the third fiber optic channel in the fiber optic module becomes operational when the second fiber optic channel fails.

26. The method of claim 23 further comprising:
detecting when the first and second fiber optic channels fail in the fiber optic module.

27. The method of claim 26 wherein,
the third fiber optic channel in the fiber optic module becomes operational when the detecting detects when the first fiber optic channel fails.

28. The method of claim 26 wherein,
the third fiber optic channel in the fiber optic module becomes operational when the detecting detects when the second fiber optic channel fails.

29. The method of claim 23 further comprising:
providing a first detector to detect when the first fiber optic channel fails in the fiber optic module.

30. The method of claim 23 further comprising:
providing a second detector to detect when the second

fiber optic channel fails in the fiber optic module.

31. The method of claim 23 further comprising:

providing a first detector and a second detector to respectively detect when the first fiber optic channel fails and the second fiber optic channel fails in the fiber optic module.

32. A fiber optic module for coupling photons between optoelectronic devices and optical fibers, the fiber optic module comprising:

a base;

a first horizontal printed circuit board (PCB) arranged parallel to a first optical axis of a first optoelectronic device, the first optoelectronic device having terminals coupled to the first horizontal printed circuit board, the first horizontal printed circuit board arranged parallel to the base;

a second vertical printed circuit board (PCB) arranged parallel to a second optical axis of a second optoelectronic device, the second optoelectronic device having terminals coupled to the second vertical printed circuit board, the second vertical printed circuit board arranged perpendicular to the base;

a third horizontal printed circuit board (PCB) arranged parallel to a third optical axis of a third optoelectronic device, the third optoelectronic device having terminals coupled to the third horizontal printed circuit board, the third horizontal printed circuit board arranged parallel to the base; and

wherein the third horizontal printed circuit board and the third optoelectronic device to provide redundancy for the fiber optic module.

33. The fiber optic module of claim 32 further comprising:

a housing coupled to the base.

34. The fiber optic module of claim 33 wherein,

the housing is a shielded housing to encase the first, second and third printed circuit boards to reduce electromagnetic interference (EMI).

35. The fiber optic module of claim 32 wherein,

the base has a first, a second and a third opening;

the first printed circuit board has a plurality of pins extending through the first opening in the base to couple to a system;

the second printed circuit board has a plurality of pins extending through the second opening in the base to couple to the system; and

the third printed circuit board has a plurality of pins extending through the third opening in the base to couple to the system.

36. The fiber optic module of claim 35 wherein,

the first, second and third openings in the base are a plurality of pin holes in the base.

37. The fiber optic module of claim 35 wherein,

the first, second and third openings in the base are a first, second, and third cutouts respectively in the base.

38. The fiber optic module of claim 32 wherein, the first, second and third printed circuit boards further

comprise:

electrical components coupled between the first optoelectronic device and the plurality of pins of the first printed circuit board and between the second optoelectronic device and the plurality of pins of the second printed circuit board and between the third optoelectronic device and the plurality of pins of the third printed circuit board, the electrical components for controlling the first, second, and third optoelectronic devices.

39. The fiber optic module of claim 38 wherein, the first printed circuit board further comprises:

a ground plane to reduce electro-magnetic fields generated by the electrical components.

40. The fiber optic module of claim 38 wherein, the second printed circuit board further comprises:

a ground plane to reduce electro-magnetic fields generated by the electrical components.

41. The fiber optic module of claim 38 wherein, the third printed circuit board further comprises:

a ground plane to reduce electro-magnetic fields generated by the electrical components.

42. The fiber optic module of claim 32 further comprising:

a first optical block coupled to the first optoelectronic device, the first optical block having a first opening to receive the first optoelectronic device, and a first lens to couple photons between the first optoelectronic device and an optical fiber;

a second optical block coupled to the second optoelectronic device, the second optical block having a second opening to receive the second optoelectronic device, and a second lens to couple photons between the second optoelectronic device and an optical fiber; and

a third optical block coupled to the third optoelectronic device, the third optical block having a third opening to receive the third optoelectronic device, and a third lens to couple photons between the third optoelectronic device and an optical fiber.

43. The fiber optic module of claim 42 further comprising:

a nose to receive an optical fiber connector and to hold an optical fiber substantially fixed and aligned with an optical opening of the optical block.

44. The fiber optic module of claim 43 further comprising:

a nose shield surrounding the nose to reduce electromagnetic interference.

45. The fiber optic module of claim 32 further comprising:

an optical block coupled to the first, second and third optoelectronic devices, the optical block having

a first, second and third openings to receive the first, second and third optoelectronic devices respectively, and

a first, second, and third lens to couple photons between the first, second and third optoelectronic devices and first, second, and third optical fibers respectively.

46. A fiber optic module for coupling photons between optoelectronic devices and optical fibers, the fiber optic module comprising:

a base having a first, a second and a third opening;

a first horizontal printed circuit board (PCB) arranged parallel to a first optical axis of a first optoelectronic device, the first optoelectronic device having terminals coupled to the first horizontal printed circuit board, the first horizontal printed circuit board arranged parallel to the base, the first horizontal printed circuit board having a plurality of pins extending through the first opening in the base to couple to a system;

a second vertical printed circuit board (PCB) arranged parallel to a second optical axis of a second optoelectronic device, the second optoelectronic device having terminals coupled to the second vertical printed circuit board, the second vertical printed circuit board arranged perpendicular to the base, the second vertical printed circuit board having a plurality of pins extending through the second opening in the base to couple to the system;

a third horizontal printed circuit board (PCB) arranged parallel to a third optical axis of a third optoelectronic device, the third optoelectronic device having terminals coupled to the third horizontal printed circuit board, the third horizontal printed circuit board arranged parallel to the base, the third horizontal printed circuit board having a plurality of pins extending through the third opening in the base to couple to the system, wherein the third horizontal printed circuit board and the third optoelectronic device to provide redundancy for the fiber optic module; and

a shielded housing coupled to the base to encase the first horizontal, second vertical and third horizontal printed

circuit boards to reduce electromagnetic interference (EMI).

47. The fiber optic module of claim 45 further comprising:

an optical block coupled to the first, second and third optoelectronic devices, the optical block having

a first, second and third openings to receive the first, second and third optoelectronic devices respectively, and

a first, second, and third lens to couple photons between the first, second and third optoelectronic devices and first, second, and third optical fibers respectively.

48. The fiber optic module of claim 47 further comprising:

a nose to receive an optical fiber connector and to hold the first, second, and third optical fibers substantially fixed and aligned with the first, second, and third optical openings of the optical block.

49. The fiber optic module of claim 48 further comprising:

a nose shield surrounding the nose to reduce electromagnetic interference.

50. A fiber optic module for coupling photons between optoelectronic devices and optical fibers, the fiber optic module comprising:

a base having a first, a second and a third opening;

a first vertical printed circuit board (PCB) arranged parallel to a first optical axis of a first optoelectronic device, the first optoelectronic device having terminals coupled to the first vertical printed circuit board, the first

vertical printed circuit board arranged perpendicular to the base, the first vertical printed circuit board having a plurality of pins extending through the first opening in the base to couple to a system;

a second horizontal printed circuit board (PCB) arranged parallel to a second optical axis of a second optoelectronic device, the second optoelectronic device having terminals coupled to the second horizontal printed circuit board, the second horizontal printed circuit board arranged parallel to the base, the second horizontal printed circuit board having a plurality of pins extending through the second opening in the base to couple to the system;

a third vertical printed circuit board (PCB) arranged parallel to a third optical axis of a third optoelectronic device, the third optoelectronic device having terminals coupled to the third vertical printed circuit board, the third vertical printed circuit board arranged perpendicular to the base, the third vertical printed circuit board having a plurality of pins extending through the third opening in the base to couple to the system, wherein the third vertical printed circuit board and the third optoelectronic device to provide redundancy for the fiber optic module; and

a shielded housing coupled to the base to encase the first vertical, second horizontal and third vertical printed circuit boards to reduce electromagnetic interference (EMI).

51. The fiber optic module of claim 50 further comprising:

an optical block coupled to the first, second and third optoelectronic devices, the optical block having

a first, second and third openings to receive the first, second and third optoelectronic devices respectively, and

a first, second, and third lens to couple photons between

the first, second and third optoelectronic devices and first, second, and third optical fibers respectively.

52. The fiber optic module of claim 51 further comprising:

a nose to receive an optical fiber connector and to hold the first, second and third optical fibers substantially fixed and aligned with the first, second and third optical openings of the optical block.

53. The fiber optic module of claim 52 further comprising:

a nose shield surrounding the nose to reduce electromagnetic interference.

54. A fiber optic module for coupling photons between optoelectronic devices and optical fibers, the fiber optic module comprising:

a base having a first, a second and a third opening;

a first horizontal printed circuit board (PCB) arranged parallel to a first optical axis of a first optoelectronic device, the first optoelectronic device having terminals coupled to the first horizontal printed circuit board, the first horizontal printed circuit board arranged parallel to the base, the first horizontal printed circuit board having a plurality of pins extending through the first opening in the base to couple to a system;

a second horizontal printed circuit board (PCB) arranged parallel to a second optical axis of a second optoelectronic device, the second optoelectronic device having terminals coupled to the second horizontal printed circuit board, the second horizontal printed circuit board arranged parallel to the base, the second horizontal printed circuit board having a

plurality of pins extending through the second opening in the base to couple to the system;

a third horizontal printed circuit board (PCB) arranged parallel to a third optical axis of a third optoelectronic device, the third optoelectronic device having terminals coupled to the third horizontal printed circuit board, the third horizontal printed circuit board arranged parallel to the base, the third horizontal printed circuit board having a plurality of pins extending through the third opening in the base to couple to the system, wherein the third horizontal printed circuit board and the third optoelectronic device to provide redundancy for the fiber optic module; and

a shielded housing coupled to the base to encase the first horizontal, second horizontal and third horizontal printed circuit boards to reduce electromagnetic interference (EMI).

55. The fiber optic module of claim 54 further comprising:

an optical block coupled to the first, second and third optoelectronic devices, the optical block having

a first, second and third openings to receive the first, second and third optoelectronic devices respectively, and

a first, second, and third lens to couple photons between the first, second and third optoelectronic devices and first, second, and third optical fibers respectively.

56. The fiber optic module of claim 55 further comprising:

a nose to receive an optical fiber connector and to hold the first, second, and third optical fibers substantially fixed and aligned with the first, second, and third optical openings of the optical block.

57. The fiber optic module of claim 56 further comprising:

a nose shield surrounding the nose to reduce electromagnetic interference.

58. A fiber optic module for coupling photons between optoelectronic devices and optical fibers, the fiber optic module comprising:

a base having a first, a second and a third opening;

a first vertical printed circuit board (PCB) arranged parallel to a first optical axis of a first optoelectronic device, the first optoelectronic device having terminals coupled to the first vertical printed circuit board, the first vertical printed circuit board arranged perpendicular to the base, the first vertical printed circuit board having a plurality of pins extending through the first opening in the base to couple to a system;

a second vertical printed circuit board (PCB) arranged parallel to a second optical axis of a second optoelectronic device, the second optoelectronic device having terminals coupled to the second vertical printed circuit board, the second vertical printed circuit board arranged perpendicular to the base, the second vertical printed circuit board having a plurality of pins extending through the second opening in the base to couple to the system;

a third vertical printed circuit board (PCB) arranged parallel to a third optical axis of a third optoelectronic device, the third optoelectronic device having terminals coupled to the third vertical printed circuit board, the third vertical printed circuit board arranged perpendicular to the base, the third vertical printed circuit board having a plurality of pins extending through the third opening in the

base to couple to the system, wherein the third vertical printed circuit board and the third optoelectronic device to provide redundancy for the fiber optic module; and

a shielded housing coupled to the base to encase the first vertical, second vertical and third vertical printed circuit boards to reduce electromagnetic interference (EMI).

59. The fiber optic module of claim 58 further comprising:

an optical block coupled to the first, second and third optoelectronic devices, the optical block having

a first, second and third openings to receive the first, second and third optoelectronic devices respectively, and

a first, second, and third lens to couple photons between the first, second and third optoelectronic devices and first, second, and third optical fibers respectively.

60. The fiber optic module of claim 59 further comprising:

a nose to receive an optical fiber connector and to hold the first, second and third optical fibers substantially fixed and aligned with the first, second and third optical openings of the optical block.

comprising61. The fiber optic module of claim 60 further:

a nose shield surrounding the nose to reduce electromagnetic interference.